Laterality research in premature newborns

Investigação da lateralidade em recém-nascidos prematuros
Investigación de lateralidad en recién nacidos prematuros

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ABSTRACT | This study aimed at investigating the existence of hand-mouth coordination and manual preference in premature newborns from the gustatory stimulation, comparing the laterality of the babies and their parents. This is an experimental and analytical study with double-blind procedure. A total of 90 premature newborns from a public maternity of Sergipe participated in this study. The test lasted for 15 minutes, which was divided into three periods of five minutes. In the first five minutes, no stimulation was applied in the initial baseline (BL1); in the second moment, there was a gustatory stimulation with sucrose for analysis at 12% or water in five doses of 0.2 mL applied every minute; and in the last period, the final baseline (BL2), it was observed that the newborn was without application of stimulus for five minutes. Recording was performed for the frequency and duration of behaviors from the right (RHM) and/or left (LHM) hands in the oral region and suction from the right (SRH) and/or left (SLH) hands of newborns during the behavioral states (deep sleep, light sleep, drowsy, alert, restless/irritated, and crying) presented by them. Data were performed in the Statistical Package for the Social Sciences software. As a result, we found a strong correlation of RHM and SRH in BL2, regardless of the stimulus received, showing that stimulation increased the correlation of the right side behaviors. Further research work is suggested to be performed on laterality with a higher number of left-handed parents in the sample.

Keywords | neonatology; infant, premature; infant, newborn; functional laterality.

RESUMO | O estudo objetivou investigar a existência de coordenação mão-boca e preferência manual em recém-nascidos (RNs) prematuros a partir da estimulação gustativa, comparando a lateralidade dos bebês e seus genitores. Trata-se de estudo experimental e analítico, com procedimento duplo-cego. Participaram 90 RNs prematuros de uma maternidade pública de Sergipe. O teste durou 15 minutos, dividido em 3 períodos de 5 minutos. Nos primeiros 5 minutos, linha de base inicial – LB1, nenhum estímulo foi aplicado. No segundo momento, houve estimulação gustativa com sacarose para análise (PA) a 12% ou água, em 5 doses de 0,2 mL a cada minuto; e no último período, linha de base final – LB2, houve observação do recém-nascido sem aplicação de estímulo, durante 5 minutos. Foi realizado registro da frequência e duração dos comportamentos das mãos direita (MBD) e/ou esquerda (MBE) na região oral e sucção das mãos direita (SMD) e/ou esquerda (SME) dos RNs durante os estados comportamentais (sono profundo, sono leve, sonolento, alerta, agitado/irritado e choro) apresentados por estes. Os dados foram executados no *software* Statistical Package for the Social Sciences. Como resultado encontrou-se correlação forte de MBD e SMD na LB2, independente do estímulo recebido, evidenciando que a estimulação aumentou a correlação dos comportamentos do lado direito do corpo. Sugere-se realização de novas pesquisas sobre lateralidade, contemplando maior número de pais sinistros na amostra.

Descritores | neonatologia; prematuro; recém-nascido; lateralidade funcional.

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RESUMEN | El objetivo del estudio fue investigar la existencia de coordinación mano-boca y la preferencia manual en recién nacidos prematuros a partir de la estimulación gustativa, comparando la lateralidad de los bebes y sus progenitores. Se trata de un estudio experimental y analítico, con procedimiento doble ciego. Participaron 90 recién nacidos prematuros de una maternidad pública de Sergipe. El test duró 15 minutos, dividido en tres períodos de cinco minutos. En los primeros cinco minutos, línea de base inicial – LB1, ningún estímulo fue aplicado. En un segundo momento, existió estimulación gustativa con sacarosa PA a 12% o agua, en cinco dosis de 0,2 mL a cada minuto, y en el último período, línea de base final – LB2, existió observación del recién nacido sin aplicación de estímulo, durante cinco minutos. Fue realizado registro de la frecuencia y duración de los comportamientos en la mano derecha (MBD) y/o mano izquierda (MBI) en la región oral y succión de la mano derecha (SMD) y/o izquierda (SMI) de los recién nacidos durante los estados comportamentales (sueño profundo, sueño leve, somnoliento, alerta, agitado/irritado y llanto) presentados por estos. Los datos fueron analizados en el software Stastistical Package for the Social Sciences. Como resultado se encontró correlación fuerte de MBD y SMD en la LB2, independiente del estímulo recibido, evidenciando que la estimulación aumentó la correlación de los comportamientos del lado derecho del cuerpo. Se sugiere realización de nuevas investigaciones sobre lateralidad, contemplando mayor número de padres zurdos en la muestra.

Palabras clave | neonatología; prematuro; recién nacido; lateralidad funcional.

INTRODUCTION

The preferential use of a hand is a common characteristic among humans[1]. The functional asymmetric nature favoring one side is present both in free and focused activities[2,3].

Taking the hands in the mouth is a behavior that constitutes one of the first demonstrations of early sensorimotor integration associated with different motor systems[4]. A study carried out in term newborns through the gustatory stimulation, evidenced an integrated sensorimotor system and a manual preference of the right side in the first living hours, which is probably associated with intrauterine development[5].

Often, infants and children with atypical motor development may present some difficulties in manual skills[6], although the manual preference development is highly manageable and sensitive to new sensorimotor experiences[7-9].

Though the manual asymmetry is expressed in different behaviors, it seems to have a biological origin and is defined by genetic and sociocultural factors[10,11]. It is said that laterality is determined by phylogenesis, being the manual preference caused by inter-lateral asymmetry from the increased capacity of motor control with the preferred hand in comparison to the non-preferred one[12-16]. The genes would bring in their code distinguished specifications about the development of brain hemispheres, determining which of these genes would be dominant ones concerning some particular functions[17].

The term newborns present specific behaviors regarding feeding promptness when submitted to sucrose gustatory stimulation for analysis[5,18,19]. Putting the hands in the mouth and sucking them, with more incidence of the right limb, has shown an integrated sensorimotor system that is associated mainly with the right side of the body[5,18].

One of the objectives of this study was to observe the hand-mouth coordination in premature newborns from gustatory stimulation and to investigate the possible manual preference by comparing their laterality to the preference of laterality (right or left-handed) of their genitors.

METHODOLOGY

This investigation was approved by the Research Ethics Committee of Universidade Federal de Sergipe (UFS), included in the project "Development of Nourishment Function in Premature Newborns [*Desenvolvimento da Função de Alimentação em Recém-nascidos Prematuros*]", under number CAAE 0027.0.107.000-11. The free informed consent form was also signed.

This is an experimental and analytical study with data collection in Maternidade Nossa Senhora de Lourdes, in Aracaju, Sergipe, Brazil.

A total of 90 premature newborns participated in the study. The inclusion criteria of this study included gestational age (GA) lower than 36 weeks, curve of appropriate intrauterine growth for the GA, and clinical instability when the test was applied. Subjects with hypoglycemia risk, neurological and heart intercurrences, syndromes and/or malformations, and respiratory support were excluded from the investigation.

The test lasted for 15 minutes and was composed of three five-minute periods, without intervals. In the initial baseline (BL1), no stimulation was applied. In the

second moment, there was gustatory stimulation (sucrose solution for analysis at 12% or water) with five 0.2 mL doses, orally applied in intervals of one minute each; and in the last period, in the final baseline (BL2), no stimulation was observed. Recording was performed using a DSC-HX1 digital camera (Sony), supported on a VT-131 tripod (Vanguart).

The procedure was carried out in the nursery room of the joined lodging. The newborns were fed and their diapers were changed to avoid discomforts. The interval period between breastfeeds was not registered, because almost all the newborns were in exclusive breastfeeding, without an established schedule. For recording, the newborn was positioned in a transportation cradle in the supine decubitus position.

The newborns were distributed into the following two groups: water (46 subjects) and sucrose for analysis at 12% (44 subjects). The solution management was performed by the double-blind procedure.

Analysis of the videos was performed by three independent judges (they did not have access to registrations done by other people), and the concordance was when at least two judges registered the same event exactly at the same time (second) of the occurrence.

Previously, in the pilot study, the judges' training was also included. All the judges were students of Speech Therapy, scientific initiation investigators inserted in the research subject, who were trained by the professor in charge from the experience of a previous work described in the published literature[5,18].

In the Excel database, the judges recorded the frequency and duration of specific behaviors (RHM/LHM, SRH/SLE) and of behavioral states (deep sleep, light sleep, drowsy, alert, restless/irritated, and crying)[18] from the 90 newborns that were studied, second after second.

Determination of each behavioral state and specific behavior observed were in accordance with the following parameters, which were based on the previous studies[5,18]:

- The deep sleep behavioral state was characterized by the regular respiration, absence of spontaneous motor activities, and maintenance with closed eyes, with absence of nystagmus.
- The light sleep behavioral state was characterized by irregular respiration, eventual occurrences of body movements, and closed or half-opened eyes, with presence of nystagmus.
- The drowsy behavioral state was characterized by the eventual existence of stretching and yawning movements and by the newborn instability to stay in this behavioral state.
- The alert behavioral state was characterized by the low level of global motor activity, and the newborn has a clear concentration activity.
- The restless/irritated behavioral state was considered from signs of newborn uneasiness, such as the presence of high motor activity level with spasms and dreads.
- The crying behavioral state was defined as an intense crying that does not stop without an intervention, with high level of global motor activity.
- The specific behavior of hand inside the mouth was characterized by the contact of one or both hands and/or fingers in the oral region. This is the area corresponding to the lips, oral cavity (outline of the upper and lower lips, area of the cheeks, palatine region, sublingual region, and isthmus of the fauces), tongue, and floor of the mouth cavity[18].
- The hand suction behavior was characterized by the contact of one or both hands and/or fingers in the oral region, concomitantly to the incidence of suction movements.

Both the hand into the mouth and the hand suction behaviors were classified according to the side used (right or left). When the newborn used both hands, the RHM and LHM behaviors were registered together.

Data registered in the Excel spreadsheet were performed in the Statistical Package for the Social Sciences (SPSS) software.

In the statistical treatment[20], correlation of the behavioral states and specific behaviors of all 90 newborns were done, regardless of the managed stimulus and in the two groups separately. To characterize the population, measures of central tendency (mean), variability (standard deviation), and prevalence (absolute and relative) were used. To test data normality, Shapiro-Wilk's test was applied. Because of the absence of normality, Mann-Whitney's non-parametric test was used to compare the means. Spearman's correlation test verified the correlation between behavioral states and specific behaviors in every moment of the test. Values between 0.1 and 0.3 were considered weak; between 0.4 and 0.6 were considered moderate; above 0.7 were considered strong; and values were considered ideal when equal to 1.0. All p-values lower than 5% ($p<0.05$) were considered to be statistically significant.

RESULTS

From the 90 studied newborns, 48.9% newborns were male participants and 51.1% newborns were female participants, with a mean GA of 34.11 weeks at birth,

mean corrected GA of 34.91 weeks, and mean age after birth of 2.113 grams. The percentage of right-handed mothers was 83.7% and left-handed ones was 16.3%, without any ambidextrous. A total of 86% of the fathers were right-handed, 12.8% fathers were left-handed, and 1.2% fathers were ambidextrous.

In the RHM and LHM behaviors, there was an increase of correlation power of BL1 (0.622) to BL2 (0.790), when the total newborns were considered regardless of the provided stimulus. In the LHM behavior, moderate correlations were found more (0.661; 0.695) in BL2 than in the RHM behavior, in which there was a strong correlation in all the behavioral states with the exception of deep sleep that did not happen in any newborn in this investigation.

When the groups were separately analyzed (water or sucrose), no significant differences were found between the stimuli. Both for the LHM and for RHM behaviors, there were increases of moderate correlation (0.740) in BL1 to strong correlation (0.904) in BL2. However, this correlation increase happened more significantly for the RHM behavior, because there was a higher frequency of strong correlations in BL2 for RHM than for LHM, especially in the light sleep and alert behavioral states.

For the SRH behavior, considering all newborns in their totality, regardless of the received stimuli, a strong correlation (0.747) was reported in BL1 for the drowsy state and weak correlation (0.294) was reported for the alert state. However, for the SRH behavior in BL2, there was a strong correlation reported in the light (0.703) and restless/irritated (0.182) sleep states, and moderate correlation was reported in the drowsy (0.457) and alert (0.695) states. In general, a weak correlation (0.294) of the SRH behavior was observed only in BL1 for the alert behavioral state. The SLH behavior occurred with moderate correlation (0.663) in the alert behavioral state and strong correlation (1.000) in the restless/irritated behavioral state in BL1, and only the moderate correlation (0.607) was kept in BL2.

If separately considered, the water group had a weak correlation (0.365) for the SRH behavior in the alert behavioral state at BL1. However, at BL2, the correlation in this state and in the restless/irritated state was strong, with correlation values of 0.783 and 0.807, respectively. Still in the SRH behavior, the sucrose group had already presented strong correlations (0.716) in the drowsy state, and weak correlations (0.216) in the alert state at BL1, changing for moderate correlation (0.468; 0.652) for the BL2, respectively. In the water group, it was possible to notice a strong correlation at BL2 for SRH (0.783; 0.807), differently from the SLH, which did not present a strong correlation at BL2. However, the sucrose group elicited the SLH behavior reactions with a stronger correlation (1.000; 1.000; 0.759), if compared with the water group at BL2.

When the laterality found in newborns was compared with the laterality preference (left- or right-handed) of his/her parents, for newborns of right-handed parents, the RHM behavior at BL1 presented moderate correlation (0.660; 0.614; 0.687), and at BL2 it became strong correlation (0.722; 0.757; 0.834) in light, alert, and restless/irritated sleep behavioral states, respectively. With left-handed parents, the RHM behavior presented almost the same correlation, i.e., at BL1 it was moderate, but became strong at BL2 in the alert and restless/irritated behavioral states.

In the LHM behavior in right-handed parents, an increase of the moderate correlation at BL1 to strong correlation at BL2 was observed; with left-handed parents, the LHM behavior at BL1 presented only one weak correlation (0.262) that became strong correlation (0.792) at BL2 in the alert state. For SRH behavior, in newborns of right-handed parents, a strong correlation was observed at BL1, which increased at BL2. In the left-handed genitors, there was no SRH significance at BL1, and from stimulation, this correlation did not change to moderate correlation (0.643) at BL2 in the alert behavioral state.

For the SLH behavior in newborns of right-handed parents, both moderate (0.672) and strong (1.000) correlations were observed at BL1 in the alert and restless/irritated behavioral states, respectively, and more strong correlations were observed at BL2 in the light sleep and drowsy behavioral states. However, no correlation of the SLH behavior in left-handed parents was observed.

DISCUSSION

The specific behaviors studied were discussed according to each behavioral state presented by the newborns. However, it is worth mentioning that the deep sleep behavioral state did not occur in any newborn being studied.

The non-incidence of the deep sleep behavioral state might have happened because the recording was performed in a daytime routine, in a more active environment, with a higher level of noise and frequent manipulation of newborn care. Furthermore, in a 24-hour period, the deep sleep behavioral state is the one with fewer incidences in premature newborns, lasting only around 20 minutes, although it may increase its duration period according to the newborn development[21].

For the RHM behavior, it was possible to notice the predominance of moderate correlations at BL1 and strong correlations at BL2, regardless of the stimulus received. It also occurred when the groups were separately analyzed (water and sucrose). The similarity of the results demonstrated the fact that newborns were stimulated, regardless of the kind of gustatory stimulus used, contributing for unleashing behaviors in the right side of the body. This datum corroborates with the published literature, in which the gustatory stimulation was mentioned to (still in the fetal period) incite an increase in swallowing from newborns[19].

For the data about LHM behavior, there was a predominance of strong or moderate correlations at BL1 and BL2, when the newborns were analyzed in their totality or in separate groups (water and sucrose). The oral stimulation, regardless of the kind of gustatory stimulus received, did not provide the impulse for the appearance of the LHM behavior or likely to the RHM behavior. This indicates stronger correlations in specific behaviors of the right side of the body at birth. On the other hand, the published literature considers a considerable social pressure in favor of the right hand use[10-16], suggesting that the environment could also have a primary role for establishing the lateral preference and inter-lateral asymmetries of the performance[17].

In general, there was a higher correlation of behaviors of the right side of the body in premature populations under study; therefore, it seems that right-handedness is present since the fetal period[1-3,18], implying a possible neurological status that would have started its development in the intrauterine period[5,7,18].

It should be emphasized that in the premature newborns studied, data were not statistically significant when compared to the stimuli groups; therefore, gustatory preference and/or discrimination in this population was not evidenced, differently from what happened in a previous study with term newborns[5,18]. Thus, differences between the results obtained in investigations carried out in term[18] and premature newborns seem to indicate that gustatory discrimination and preference are aspects inherent to development and maturity associated with GA.

For the SRH behavior in term newborns, published literature reported a significant difference between the groups, and sucrose elicited more significant reactions in this behavior[5,18]. This was not observed in the premature newborns in this investigation. There was an influence of the gustatory stimulus in the motor control, which provided an evidence of a more efficient manual synergism when associated with the right side of the body, both for term and premature newborns. However, as already discussed, term newborns seem to present a higher gustatory discrimination[5,18,19] ability compared with the premature babies included in this study.

In the present study, the laterality data of the parents was observed to have almost the same correlation of RHM behaviors both in the group of right-handed fathers and in the left-handed fathers. In addition, newborns presenting a strong correlation of behaviors to the left side of the body had right-handed parents, which could demonstrate that laterality preference does not come from the parents. However, this aspect cannot be concluded, because the sample had a limited number of left-handed fathers, being insufficient for this analysis.

Results of this investigation are different in some aspects from data gathered in the previous studies with term newborns, mainly in questions regarding gustatory preference and discrimination[5,18]. However, data about laterality seemed to be in accordance with studies that suggested a complex combination of innate tendencies with lateralized sensorimotor experiences, which provided signals for both phylogenetic and ontogenetic determinations in the human laterality issue[17].

CONCLUSION

The possibility of more manual control of the right side of premature newborns was discerned indistinctly, although there are no evidences of gustatory preference and discrimination in this population under study. Finally, when favoring the existence of lateralized sensorimotor experiences in premature newborns' right side of their bodies, gustatory stimuli supposedly indicated the presence of right-handedness since the fetal period.

Laterality preference could not be proven in this study exclusively from parents' laterality, due to the low number of left-handed parents in the sample. Further research work on laterality should be carried out with a higher number of left-handed parents.

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